METEOR cruise M43/2

Scientific Report

Las Palmas - Cadiz

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- 13 January 1999

Chief Scientist: **Gerhard Graf**

Abstract

Leg 43/2 was carried out to investigate particle transport from the narrow shelf of the Iberian Peninsula to the continental slope in the frame of the EU-Project OMEX II (Ocean Margin Exchange programme). The special issue of this cruise was to quantify sedimentation, bottom near particle transport, the hydrographical regime, and the exchange of biogases during winter, in order to compare these results with those of other seasons and other settings of shelf-continentals slope systems. In spite of the poor weather conditions most data have been successfully taken. A prominent result is given by the findings that the Nazaré Canyon turned out to provide a focussing of sediment and a rapid transport from the shelf to the deep-sea.

Zusammenfassung

Abschnitt 43/2 untersuchte im Rahmen des EU-Projektes OMEX II (Ocean Margin Exchange programme) den Partikeltransport vom schmalen Schelf vor der iberischen Halbinsel auf den Kontinentalhang. Der spezielle Anlass dieser Fahrt war, die Prozesse des bodennahen Partikeltransportes, der Sedimentation, die hydrographischen Randbedingungen und den Austausch von Biogasen speziell in der Wintersituation zu quantifizieren, um sie mit entsprechenden anderen Jahreszeiten und mit anderen Schelf-Kontinentalhang-Situationen vergleichen zu können. Trotz schlechter Wetterbedingungen konnten die meisten Daten erfolgreich gewonnen werden. Herausragende Ergebnisse sind die Befunde im südlich gelegenen Nazaré Canyon, die belegen, dass Canyons den Schelfexport fokussieren und für einen schnellen Transport vom Schelf bis in die Tiefsee sorgen.

Research Objectives M43/2

Leg M 43/2 served the multidisciplinary joint project of the European Union **OMEX II** (Ocean Margin Exchange; period: 1997-2000), in which 40 institutes participate. During the first application phase, research was focused on the region between Meriadzek Terrace and Porcupine Sea-Bight, whereby benthic work concentrated on a transect over Goban Spur (Celtic Sea), an example for a broad shelf. During phase II the five sub-projects focused their research on the continental slope between northern Spain to Lisbon as an example for a very narrow shelf, which is affected by upwelling processes. The major aims were:

(1) Assessment of the physically controlled advective and diffusive transport processes at different shelf edges to elaborate a numerical 3-D model.

(2) Quantification of biologically influenced vertical transport processes in along -and cross-slope direction, which result in the material exchange at continental slopes. Also in this context, a numerical model to describe processes at continental slopes has to be elaborated.

(3) Characterisation and balancing of bio-geochemical processes, which are relevant for material fluxes of carbon, nutrients and bio-reactive elements.

(4) Analysis of transport, sedimentation, accumulation as well as deposition of particles under different oceanographic conditions. Characterisation of the bottom nepheloid layer at the European continental slope. Studies of the importance of benthos communities for the carbon flux into the sediment.

5) Quantification and modelling of the exchange of carbon and biogas through the water-air-boundary layer at the continental slope.

The specific aim of this leg was to determine physical conditions and biogeochemical fluxes during the winter season.

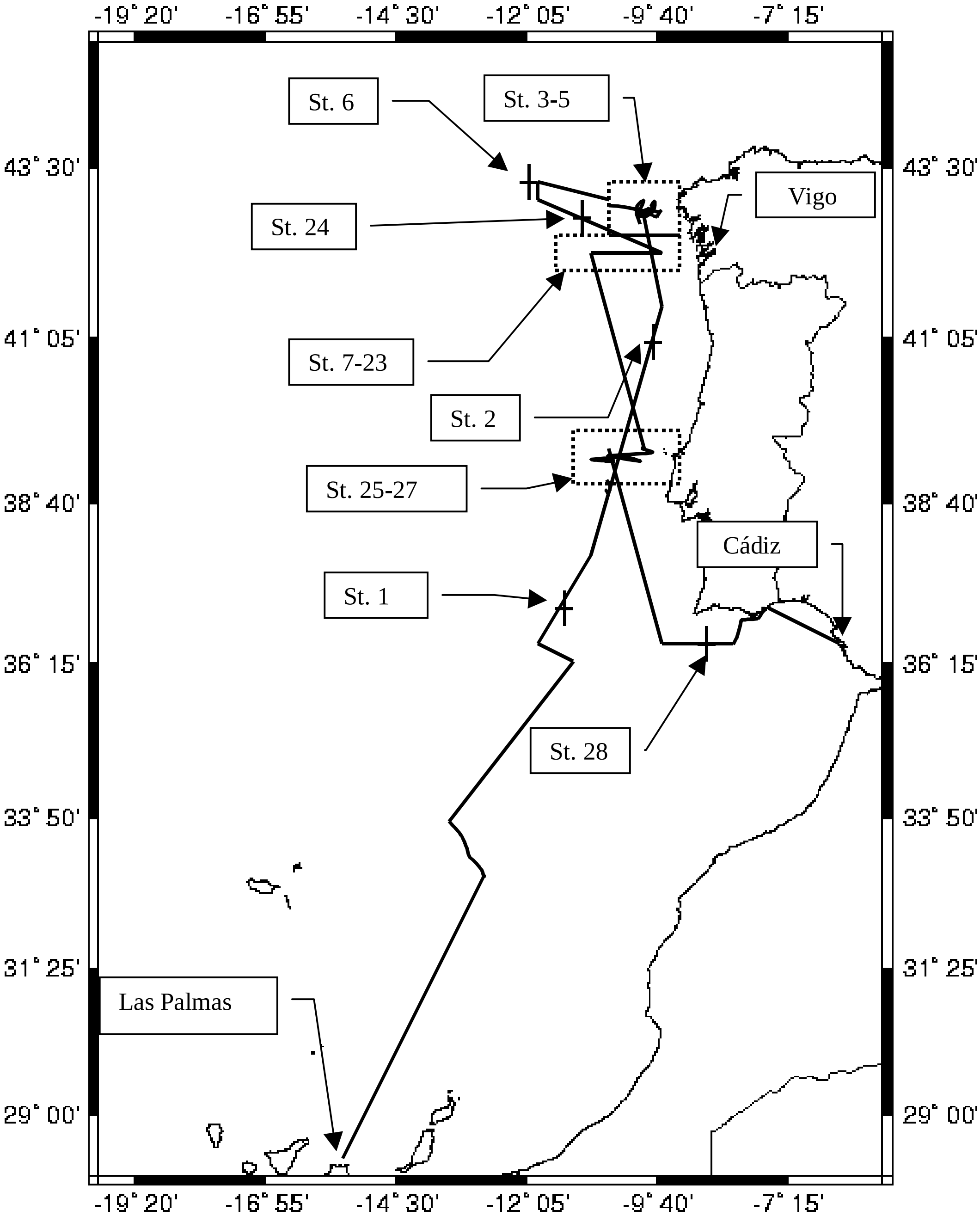

Fig. xy: Cruise track M43/2

2 - Participants

Leg M 43/2

Name	Speciality	Institute
Graf, Gerhard	Chief scientist	UR
Behr, Hein Dieter	Meteorology	DWD
Blohm-Sievers, Elke	Microbiology	UK
Borges, Alberto	Geochemistry	UL
Bouma, Hilda	Benthosbiology	NIOO
Clement, Sian	Oceanograghy	UNWB
Franke, Uli	Benthosbiology	UR
Friis, Karsten	Geochemistry	IfM - Kiel
Garcia, Carla	Geology	UCTRA
Heeschen, Katja	Geochemistry	GEOMAR
Joao Luis da Silva Curdia	Benthosbiology	UA
Kähler, Anja	Benthosbiology	GEOMAR
Karpen, Volker	Benthosbiology	GEOMAR
Keir, Robin	Geochemistry	GEOMAR
Lavaleye, Marc	Benthosbiology	NIOZ
Lowry, Roy	Data mangment	BODC
Moodley, Leon	Benthosbiology	NIOO
Nachtigall, Kerstin	Planktology	IfM - Kiel
Ochsenhirt, Wolf-Dieter	Meteorology	DWD
Peine, Florian	Benthosbiology	UR
Peinert, Rolf	Planktology	IfM - Kiel
Philip, Eva	Benthosbiology	GEOMAR
Pielenz, Holger	Benthosbiology	UR
Rehder, Gregor	Geochemistry	GEOMAR
Schmidt, Sabine	Geochemistry	UCTRA
Spyres, Georgina	Geochemistry	PML
Thomsen, Laurenz	Benthosbiology	GEOMAR
Torres, Ricardo	Oceanograghy	UNWB
Witzel, Karl-Paul	Microbiology	MPI Plön

Participating Institutes

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UNWB	School of Ocean Sciences Univ. Bangor Menai Bridge, Gwynedd LL 59 5EY UK
BODC	Bidston Observatory, POL-CCMS Birkenhead, Merseyside L43 7RA UK
NIOO	Netherlands Institute of Ecology Center for Estuarine and Coastal Ecology (CEMO) Korringaweg 7 4401 NT Yerseke
UCTRA	Universidade do Algarve P- 8000 Faro Portugal
ULg	Univ. Liege B-4000 Sart Tilman Belgium
PML	Plymouth Marine Laboratory PML-CCMS West Hoe, Plymouth PL1 3DH UK
UR	Universität Rostock Meeresbiologie Freiligrathstrasse 7/8 18055 Rostock Germany
GEOMAR	Forschungszentrum für marine Geowissenschaften der Christian-Albrechts Universität zu Kiel Wischhofstr. 1-3 24148 Kiel Germany
DWD	Deutscher Wetterdienst Geschäftsfeld Seeschifffahrt Postfach 30 11 90 20304 Hamburg Germany
MPI	Max-Plank-Institut August-Thienemann-Str. 2 24306 Plön Germany

3 - Research Programme

Carbon remineralisation by the benthic community

Remineralisation of organic matter takes place already during carbon transport processes occurring in the water column. Parameterisation of the subsequent processes acting in the benthal will be required to estimate the fraction of carbon that is recycled back into the ocean versus that which is permanently buried. A better understanding of the biological, chemical and physical processes and the measurement of the corresponding rates are required for a balance of carbon flux through the sediment.

Measurements of benthic respiration rates, biomass production and activity are necessary to estimate the role of benthic organisms for the carbon flux through the sediment. Recent results from the temperate north-east Atlantic demonstrated a strong seasonallity in benthic biomass production, respiration and activity rates which were coupled with sedimentation events. The major part of benthic carbon consumption goes into respiration, in the range of 80-95% of total benthic carbon consumption.

The main objective of the benthic program is the quantification of the biologically mediated carbon flux through the sediment by following the benthic reaction (remineralisation, burial rates) toward sedimentation pulses. The canyon areas will be studied in detail.

Additionally, a comparative study on the coral *Lophelia* living on the Iberian slope and on the Galicia Bank will be carried out. While the first population is potentially under the influence of the production in the upwelling zone, the one on Galicia Bank lives under more oceanic, on presumably nutrient poor, conditions. Comparisons of growth rates and elemental tracers in the calcium matrix, for instance, may shed light if there is an effect of the nearby continent.

Processes within the bottom boundary layer

At continental margins bottom nepheloid layers are commonly found. Lateral particle fluxes in the benthic boundary layer [BBL] far exceed the vertical fluxes from the euphotic zone. The fluxes are dominated by fast sinking particles whereas the mass of particles consists of fine slow sinking particles.

Aim of the project is the investigation of the following processes: particle transport within internal boundary layers, especially in canyons and gullies along the shelf edge, sedimentation, accumulation and mass fluxes of particulate matter. With the help of CTD-watersamplers and a transmissiometer, samples shall be taken in the deep sea and in the canyon area at the continental margin. With the help of the BIOPROBE bottom water sampler, flow velocity and light transmission will be determined and water samples at 5,10, 20 and 40 cm height above the sea floor will be taken. A particle camera will take video pictures of aggregates. Gravity cores will be used to determine sediment accumulation rates. Benthic flow simulation chambers will give information on sediment stability and particle behaviour. Thorium analyses will be done and sediment transport studies will be carried out along the shelf edge.

Microbial studies of aggregate dynamics in the benthic boundary layer

The focus of this group will be to study microbial activities and the genetic structure of the microbial communities in the water column, in the benthic boundary layer and the surface sediments on a transect across the continental margin of the OMEX area. These results will give information on the origin of particles in the BBL. Measurements of the microbial activities will address the role of bacteria in the dynamics of organic carbon across the continental margin.

To elucidate the genetic composition of the microbial communities PCR will be used with DNA-extracts from water and sediment samples to retrieve sequences of the genes coding for either 16S rRNA or the functional enzyme ammonia-monooxygenase of ammonia-oxidising bacteria. Sequence-specific electrophoresis of the PCR-products will give an overview of the species-composition within this group of bacteria. Cloning and sequencing of the PCR-products is used for identification and phylogenetic classification by DGGE. Samples will be retrieved from Niskin bottles, the bottom water sampler and the multiple corer.

Processes in the water column

The goal of the OMEX project is to determine spatial and temporal variability in the exchange of particulate and dissolved organic matter at the continental margin and thereby the role of the margins in regional elemental cycling and carbon sequestration. In this second phase, emphasis has shifted from the Goban Spur, with a gradual, wide slope and weak upwelling, to the Iberian Margin with its steep slope and strong periodic up- and downwelling cycles. As part of a multidisciplinary joint approach the Institut für Meereskunde has deployed two moorings equipped with sediment traps, in situ pumps and current meters at the mid- and outer slope along a transect at 42°38'N, in water depths of 1500 m and 2230 m. During the current period of deployment (March 1998 - Jan 1999), a number of interesting features occurred at the Iberian Margin, the imprint of which we will record in the traps by use of bulk and marker variables and radionuclide analyses of samples. We thus hope to link processes occurring at the sea surface, as seen by remote sensing and recorded on OMEX cruises, to temporal and spatial patterns of vertical and lateral particle flux. Using samples of suspended particulate matter over this 9- month deployment period collected by the newly developed in situ pumps, we will gain insights in the qualitative and quantitative patterns of SPM flux and the role of scavenging that leads to settling. Moorings IM2 and IM3 at positions 42°38.5'N, 9°42.3'W and 42°37.5'N, 10°01.5'W respectively will be recovered yielding 100 sediment trap samples, 60 in situ pump samples and 9 months of current meter data from 5 RCMs. The moorings will not be redeployed. Gradients in suspended particulate matter along- and across the slope will be determined by water column sampling and in situ pump deployments. Special emphasis will be given to sampling of the surface, intermediate and benthic nepheloid layers that will be determined using a transmissiometer and nephelometer attached to the CTD. Bulk and marker variables will be determined in these samples and used to determine gradients in these properties around the mooring positions. Additionally ADCP measurements will give information on the surface current regime.

Distribution of Surface pCO_2, $d^{13}CSCO_2$, CH_4 and Radiocarbon

Workpackage II of the OMEX Project is concerned with mesoscale variability of carbon and related fluxes in the shelf and slope waters of the Iberian Margin. Two of the objectives within this part of OMEX are (a) to trace principal water masses and their sources and (b) to assess the net air-sea exchange flux of CO_2 as well as the penetration of anthropogenic CO_2 in the region. In connection with the latter objective, the partial pressure of CO_2 in surface water as well as in the air will be surveyed continuously underway using two different equilibrator systems (intercalibration). The vertical distribution of the $^{13}C/^{12}C$ ratio in dissolved inorganic carbon will be determined on samples collected from the CTD casts in the shorebased Leibniz Laboratory at the University of Kiel. Since anthropogenic CO_2 produced by burning of fuel fuels carries a low $^{13}C/^{12}C$ ratio, these measurements provide an indication of the penetration of this CO_2 into the water column. The measurements also give an indication of the nature of the seasonal cycle of the biological pump of carbon in the area, which is dependent on upwelling and the net production of carbon.

The vertical and horizontal distribution of methane provides a contribution to the first objective above, the tracing of water masses. In relatively young deep waters, it appears that methane is oxidised on about a 50-year time scale. The proximity of possible sediment sources on the continental slope as well as the presence of water masses with ages less than 100 years in the upper 2000 meters in this region indicates that methane may provide a useful supplement to the information that one obtains from salinity, temperature and dissolved oxygen.

The vertical distribution of radiocarbon will be determined on samples collected from one or more deep CTD stations. This will also be valuable in connection with the tracing of water masses. By comparison to previous determinations 17 years ago, it should be possible to observe the temporal change in the radiocarbon distribution due to uptake of bomb-produced ^{14}C.

Determination of the net total radiation at sea

The knowledge of the spatial and temporal distribution of the net total radiation and its components at the sea-surface is important for numerous meteorological and oceanographic investigations. On the cruise of the vessel the following radiation components will be recorded: global solar radiation and atmospheric radiation. The other components closing the radiation balance equation - reflected solar radiation and terrestrial surface radiation - will be computed with the aid of numerical models tested in former cruises in the Atlantic Ocean. Further, direct solar radiation, sunshine duration, and UV-B global radiation will be measured

Narratives of the Cruise

4.2 Leg M43/2

The cruise started on 28th December, 1998, at 10:45 am, in Las Palmas under perfect weather conditions and with all scientific equipment delivered in time. 29 scientists from 6 different nations (Germany, Belgium, France, The Netherlands, United Kingdom, Portugal) were on board, representing the OMEX II programme of the European Union. This programme of the EU aims to study fluxes across the ocean margin and processes along European shelf breaks facing the North Atlantic Ocean. The expected transit time to the northern Portuguese upwelling area was 3.5 days.

Due to deteriorating weather conditions, cruise speed had to be reduced already during the second day and finally we had to stop in order to wait for a heavy storm to pass the scheduled study site. On January 1st the first samples were taken with a CTD in the outflow of the Mediterranean water, where high methane concentrations were detected (Station 1). To follow the surface currents to the North, 4 drifter buoys from the University of Bangor were deployed on 41° N, which were from there on continuously tracked by satellites. On January 3rd the main working transect off Vigo was reached but due to heavy seas, CTD casts were cancelled. Surface water was then sampled and current measurements were performed. The next day a long term sediment trap deployment was released and successfully recovered and thus one major aim of the cruise was achieved. Another mooring, which had been damaged by fishermen, could not be recovered. On January 6th Meteor reached the Galicia Bank and due again to increasingly bad weather conditions, it was not risked to release a Dutch mooring from the NIOZ institute, Texel. This deployment of artificial hard substrate for the study of deep-sea corals was still working as was indicated by a successful hydrophone contact and it was decided to recover this experiment in spring.

Within the next 5 days weather conditions improved and a full transect at 42° N including all water and sediment samplers could be covered (Stations 7 to 23). A total of 30 CTD casts and many sediment cores were carried out from the shelf down to a water depth of 2500 m. This transect was a success and provided the first winter data for this key area of the OMEX programme. During the following days another transect in the St. Nazaré Canyon was also sampled, in order to study both the distribution of particles in the lower water column and the benthic biomass and activity (Stations 25-27). With a detailed bathymetric map provided from the British colleagues it was possible to sample directly in the central conduit of the Canyon. This Canyon serves as modern conduit of organic matter and pollutants to the deep sea and will be of great interest for future work.

Although the cruise was relatively short and the weather often being bad, the scientific programme carried out was very successful and the whole OMEX community was very happy with the results. On our way back to Cadiz an additional CTD was taken for the study of the Mediterranean outflow and in support of another European project a Parasound and Hydrosweep profile was run off the city of Faro. On January 13, METEOR reached the port of Cadiz in the early evening and immediately entered a dry dock .

5.2 Leg M43/2 (OMEX)

5.2.1 Physical Oceanography

5.2.1.1 CTD Methodology (Roy Lowry, Ricardo Torres, Holger Pielenz)

The CTD system used on the cruise was a Sea Bird SBE-9+ underwater unit fitted with a Sea Bird SBE-33 12-bottle rosette. A Beckman oxygen sensor and a SeaTech 25 cm path length 661 nm wavelength transmissometer were fitted to the package. The system was driven by a Sea Bird SBE-11+ deck unit. Data were logged by a laptop PC running Seasoft version 4.214. Twelve rubber-sprung 10-litre Niskin bottles were mounted on the rosette.

The temperature, oxygen and salinity sensors were recalibrated in November 1998. No reversing thermometers were available but previous experience with SBE-9+ sensors give confidence in the accuracy of data based on such a recent calibration. Water samples were taken for post-cruise salinity determination to check the CTD salinity calibration. The oxygen sensor will be recalibrated against water bottle data from the University of Liège.

The pressure calibration was checked by comparing the sum of the CTD depth plus altimeter height against Parasound water depth measurements. Good agreement was obtained.

The CTD transmissometer (SN 104D) calibration was based on air reading data taken in September 1997. Careful measurements during the cruise indicated that the light source had deteriorated and that the voltage reading in air was now 4.597 V (blocked path reading 0.001 V).

The data will be further worked up, including spike editing and recalibration of the oxygen, transmissometer and (if necessary) salinity data after the cruise by the British Oceanographic Data Centre.

5.2.1.2 ADCP and ARGOS drifters (Ricardo Torres , Siân Clement)

Our main interest is focused on the poleward flow that develops seasonally along the slope of Eastern Iberia. During winter, the OMEX II region is generally under the influence of south-westerly winds. The upper layer circulation in this season is characterised by the presence of a narrow northward slope current which settles in November and disappears around May. This structure appears as a warm and saline intrusion (temperature 1-3ºC and salinity 0.2-0.3 psu higher than surrounding values), trapped within about 50km of the shelf break, about 200-600m deep, and flowing along the slope with characteristic velocities of 0.2-0.3 ms^{-1}, extending more than 1500 km.

The poleward flow has been poorly surveyed so far but is a general feature of most eastern boundaries around the world. Repeated transects across the slope (with ADCP and CTD) and satellite images in conjunction with ARGOS drifter data will provide information about the spatial and short temporal variability of the flow.

Method

Our group is responsible for the operation of the Vessel Mounted ADCP and the launch of 4 ARGOS tracked drifters as well as being involved in the operation of the ship CTD, all of which will help to achieve our objectives.
The VM 75kHz Broad Band RDI ADCP (installed in the moon pool of the ship) has been used throughout most of the cruise. The depth range has been the full nominal range of the instrument (500-600m) when conditions were favourable and the ship was not sailing against the prevailing sea. The software used for the acquisition of the data was RDI DAS. The settings were optimised during the first day of cruise and several parameters have been regularly checked for acquiring the best quality data (i.e. number of bins, automatic bottom tracking, etc..). The ADCP was set to average profiles over 5 minutes giving a dense spatial resolution with a vertical resolution of 16m. It was noticed that the transducer temperature sensor was consistently giving temperature readings 1.1° C less than the TSG.
On the 5th of January the 75kHz ADCP was replaced by the 150 kHz Narrow Band RDI ADCP (permanently fixed to the hull of ship) due to a failure on the communication cable. The second ADCP also experienced problems with the ADCP deck unit and the PC used to run the acquisition software which meant gaps in the data collection while it was being repaired by the electronics engineers. The depth range of the 150 kHz ADCP was 200m, recording ensembles of 5 minute averages with a vertical resolution of 8m.
During postprocessing a heading correction from the ASHTECH system onboard will be implemented as well as a calibration for the amplitude and phase offset.
Four SC40 ARGOS tracked drifters from SERPE-IESM® were released during the cruise. They are spherical (40cm of diameter) mixed layer drifters equipped with a cylindrical HOLEY SOCK drogue (8m length, 1.5m of diameter) located at a depth of 15m. The SC40 also measures the water temperature with an accuracy of ±0.3°C which is transmitted with every positioning message.

Preliminary Results
One of our main objectives for this cruise has been successfully achieved by the launch of the four drifters in a square cluster of 2nm on the 2nd of January of 1999. It can be seen in the table below, the positions of each drifter together with the drifter I.D. and exact time of release.

Table 1. Details of the launch of the ARGOS tracked drifters.

Drifter I.D.	Time	Latitude (N)	Longitude (W)
4010	08:48	40° 59.97’	9° 24.86’
3924	09:22	40° 59.86’	9° 27.75’
4558	09:52	41° 01.85’	9° 27.83’
3923	10:27	41° 01.91’	9° 25.37’

These 4 drifters have an expected life of 8 months and will be tracked for as long as they remain operational. Its data will contribute not only to the lagrangian knowledge of the poleward flow but also to estimate its statistical characteristics in terms of Mean and Eddy Kinetic Energy and Taylor mixing parameters (lateral diffusivity and lagrangian Time and Length scales).
The distribution in a square cluster will also enables us to calculate the vertical vorticity of the flow and particle dispersion. We expect them to follow the poleward flow along the eastern Iberian margin and continue along the slope into the Bay of Biscay unless they are driven offshore by mesoscale eddies associated with the slope current.

The ADCP has been continually recording data but several cross-shelf sections were requested by our group which are detailed below:

Table 2. Details of the ADCP sections.

Time of Transect		Start position		End position	
Start	End	Latitude (N)	Longitude (W)	Latitude (N)	Longitude (W)
3/1 19:15	4/1 00:21	42° 59.50’	10° 19.49’	42° 59.59’	9° 37.14’
7/1 19:37	8/1 05:00	42° 08.92’	9° 31.06’	42° 09.06’	9° 12.99’

A cross-slope CTD section (Staions 18 to 26 and 27) along 42° 9’N was carried out to determine the width and vertical scale of the poleward flow over the slope. The station positions are given in **7.2.**

During the benthos station number 24 the ADCP showed the passing of an inertial oscillation (long period wave of ~18 hours). The upper 200m of CTD and ADCP data will be used in the description of such oscillations.

Table 3. Details of the CTD deployments on station 24 on the 8-9 th of January 1999.

CTD N° (Meteor Event n°)	Time	Latitude (N)	Longitude (W)
029 (24_1)	20:12	42° 09.1’	10° 30.12’
032 (24_4)	21:32	42° 09.1’	10° 30.12’
033 (24_5)	22:22	42° 09.1’	10° 30.12’
034 (24_6)	00:22	42° 09.1’	10° 30.12’
035 (24_7)	02:19	42° 09.1’	10° 30.12’
036 (24_8)	03:13	42° 09.1’	10° 30.12’
037 (24_9)	04:01	42° 09.1’	10° 30.12’
038 (24_10)	05:00	42° 09.1’	10° 30.12’
039 (24_11)	06:30	42° 09.1’	10° 30.12’
040 (24_15)	13:48	42° 09.1’	10° 30.12’
041 (24_17)	15:07	42° 09.1’	10° 30.12’

The ADCP and CTD sections have shown the poleward flow to be a slope process extending to a depth of 700m with a characteristic velocity of $20 cms^{-1}$. The drifter trajectories moved northward following the bathymetry in good agreement with the CTD and ADCP data.

5.2.2 Marine Chemistry

5.2.2.1 pCO2 - Measurements (Alberto Borges)

The role in the global inorganic carbon cycle of continental shelf seas influenced by seasonal upwelling remains controversial because they are sites of processes that have antagonist effects on the the flux of carbon dioxide across the air-sea interface. Upwelling brings to the shelf water oversaturated in pCO_2 in respect to the atmosphere. This water has also an important nutrient content which enhances primary production that in turn reverses the air-sea gadient of pCO_2. To improve our understanding of these regions more field data are needed with an adequate resolution both in time and in space. To meet this goal, two approaches are used: the mapping of surface pCO_2 and the description of the vertical distribution of inorganic carbon.

Method

The determination of pCO_2 is carried out using both direct and indirect methods. The direct one consists to equilibrate seawater with air and then measure CO_2 using an IR analyser. The indirect one relies on the calculation of pCO_2 from experimental determinations of pH and Total Alkalinity (TAlk). These measurements can also be used to calculated the dissolved inorganic carbon (DIC) which can be used together with dissolved oxygen (Winkler method) to discuss CO_2 dynamics with linked biological, physical and chemical processes.

Preliminary Results

The underway measurement of pCO2, pH and dissolved oxygen were carried out throughout the cruise. Discrete samples for pH, TAlk and dissolved oxygen were obtained from the rosette at 12 stations and 169 dephts:

CTD001 (800,700,600,500,400,300,200,150,100,75,50,10)
CTD002 (4000, 3500, 3000, 2500, 2000, 1800, 1600, 1400, 1200, 1100, 1000)
CTD006 (200, 150, 100, 50, 10)
CTD009 (1000, 900, 800, 700, 600, 500, 400, 300, 200,100, 50,10)
CTD013 (900, 800, 700, 600, 500, 400, 300, 200,150, 100, 50,10)
CTD014 (2200, 2000, 1800, 1600, 1400, 1200, 1100, 1000)
CTD015 (1900, 1700)
CTD017 (1400, 1200, 1000, 800, 600,500, 400, 300, 200,100, 50,10)
CTD018 (1520, 1300, 1100, 900, 700, 500, 400, 300, 200, 100, 50, 10)
CTD021 (530, 400, 300, 200, 150, 100, 75, 50, 10)
CTD023 (200, 150, 100, 75, 50, 10)
CTD027 (160, 100, 75, 50, 10)
CTD038 (700, 600, 500, 400, 300, 200, 150, 100, 75, 50, 10)
CTD039 (2700, 2400, 2200, 2000, 1800, 1600, 1400, 1200, 1000, 900, 800)
CTD042 (900, 800, 700, 600, 500, 400, 300, 200, 150, 100, 75, 10)
CTD043 (3500, 3000, 2500, 2000, 1800, 1600, 1400, 1100, 1000)
CTD045 (300, 200, 150, 100, 75, 50, 30, 10)
CTD046 (2000, 1800, 1600, 1400, 1200, 1000, 900, 800, 700, 600, 500, 400)

CTD027 (160, 100, 75, 50, 10)
CTD038 (700, 600, 500, 400, 300, 200, 150, 100, 75, 50, 10)
CTD039 (2700, 2400, 2200, 2000, 1800, 1600, 1400, 1200, 1000, 900, 800)
CTD042 (900, 800, 700, 600, 500, 400, 300, 200, 150, 100, 75, 10)
CTD043 (3500, 3000, 2500, 2000, 1800, 1600, 1400, 1100, 1000)
CTD045 (300, 200, 150, 100, 75, 50, 30, 10)
CTD046 (2000, 1800, 1600, 1400, 1200, 1000, 900, 800, 700, 600, 500, 400)

The figure below shows preliminary results of underway partial pressure of CO_2 (pCO_2) and pH measurements carried out during the OMEX cruise on board of the Meteor (January 1999). The plot corresponds to the transect along the OMEX S line (42°N) obtained during the 8^{th} January. There is a marked gradient in pCO_2 values between the continental shelf and the offshore oceanic region. The higher pCO_2 values on the continental shelf can be related to a relatively weak upwelling event revealed by SST satellite images (available at http://www.pol.ac.uk/bodc/omex.html). This is confirmed by the pattern in the water temperature distribution. From the water temperature distribution the influence of the warm poleward slope current ('Navidad') is not apparent. This can be explained by the fact that the northerly winds observed prior and during the cruise inhibited significantly the Navidad.

These observations are quite different from those obtained in the same area during the Charles Darwin 110B cruise in January 1998 when the influence of the Navidad and the fresh water inputs from the rias were the dominant features influencing the subsurface distribution of pCO_2 (refer to:

M. Frankignoulle, A. Borges & K.T. Dotansi (1998) Preliminary results of the distribution of the partial pressure of CO_2 (pCO_2) and related parameters off the Galician coast, in summer 1997 and winter 1998. OMEX first annual report. Available at http://www.pol.ac.uk/bodc/omex.html)

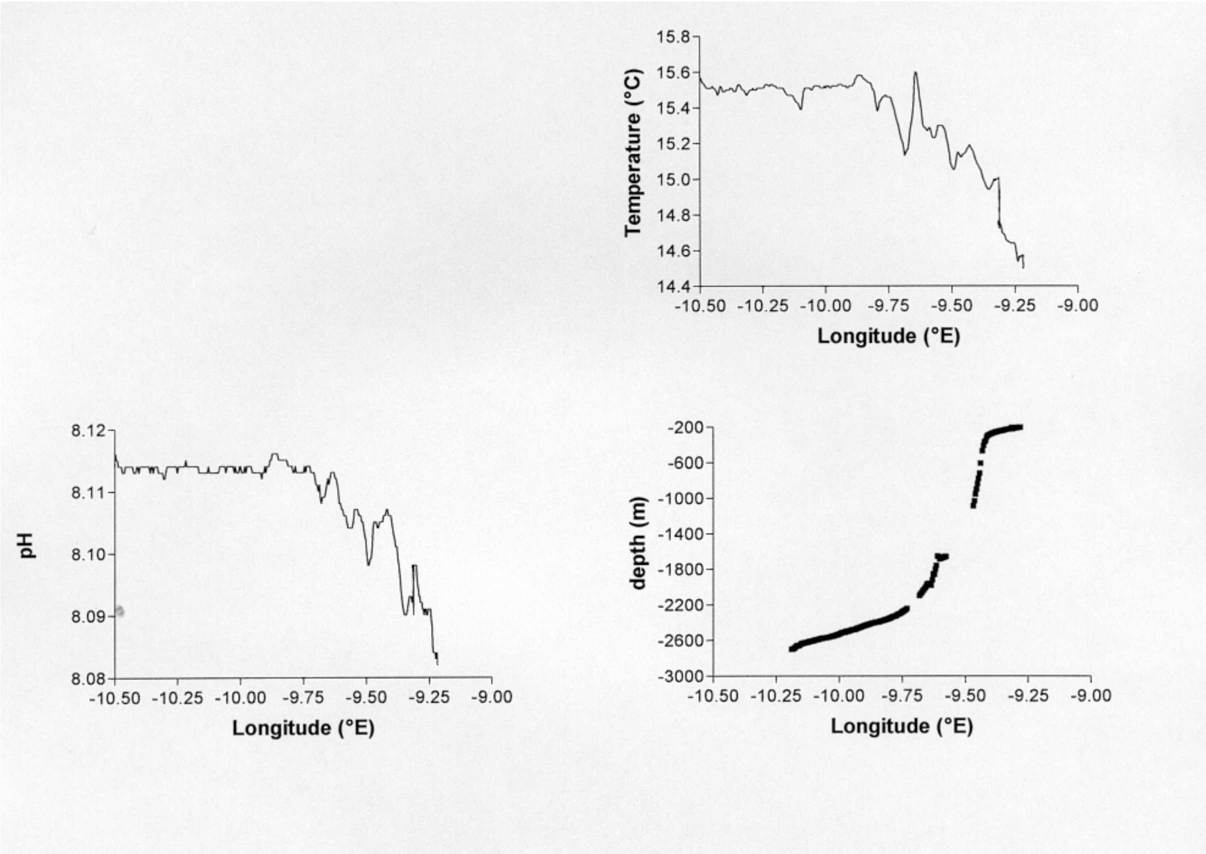


Fig.: xy Water depth, Temperature an pH on a transect across the continental slope at 42°N corresponding to the OMEX S-line.

5.2.2.2 Spectrophotometric pH Measurement on Discrete Water Samples (K. Friis)

A newly designed fully automated spectrophotometric pH-System for high accuracy pH-measurement has been tested for 'at sea conditions'. 167 discrete water samples were analyzed from 12 hydrocasts of 8 hydrographic stations. 19 samples were stored for dissolved inorganic carbon (DIC) home-lab measurements.

The spectrophotometric pH determination is based on pH-dependent indicator-dye-spectra. For high accuracy pH-measurement in sea water, there are two indicators (thymolblue and meta-cresolpurple) which have been calibrated on absolute methods within ± 0.002 pH-units on the total seawater scale.

The first aim of the cruise participation was to figure out the precision and estimate the accuracy of the pH-system. For the precision-study this was done by replicate measuements. For the accuracy estimate certified reference materials (CRM) from the Scripps Institution of Oceanography were measured. In addition samples were measured for pH and Alkalinity (see for A. Borges) and replicate samples were stored for home-lab DIC measurements. If Alkalinity and DIC are known, the pH can be calculted i.e. compared to the spectrophotometric determined pH.

The second aim of participation was to check the consistency between the two indicator-dyes through measurements on replicate samples with both indicators.

Shipboard results are a system precision of better than ± 0.002 pH-units for replicate samples. A first comparison of the pH-indicators meta-cresol purple and thymolblue show good agreements between both indicator-calibrations.

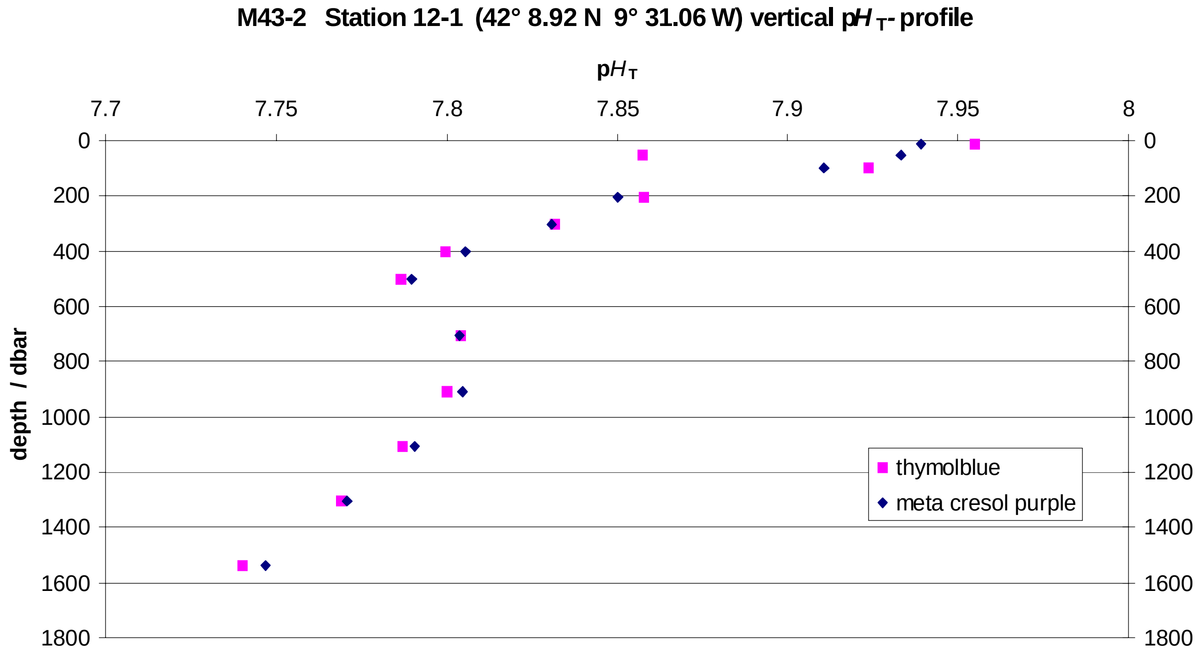


Fig. xy: The profile shows so far uncorrected pH measurements

5.2.2.3 Determination of DOC and DON using High Temperature Catalytic Oxidation (Georgina Spyres)

One of the key areas of investigation in the OMEX project (OMEX II-II Work Package II) is Dissolved Organic Carbon (DOC) and its impacts on the marine carbon cycle. Additional investigations on the processes that control the fluxes of organic carbon at the ocean margin will aid in the constructing and understanding of the carbon cycle and its associated elements (eg. Dissolved Organic Nitrogen, DON). The analysis of DOC and DON involves the use of a rapid and precise technique, the high temperature catalytic oxidation (HTCO) technique.
Cruise M43/2 gave the opportunity to measure organic matter at the Iberian margin during the winter season. In addition it allowed an inter-annual investigation of DOC/DON results.

Method
DOC/DON: The collection and preservation technique of sea water samples involved the 'clean' collection of water from the CTD rosette and subsequent filtration through GFF filters (47mm∅) into ashed (450°C, 4hr) 10ml glass ampoules using a high-purity oxygen closed-filtration system. The purpose of filtering is to exclude the particulate fraction from the final sample. Furthermore, each sample was acidified with orthophosphoric acid (30µl) for preservation purposes. The ampoules were finally flame-sealed until analysis.
The HTCO technique involves the direct injection of aliquots of seawater samples that have been filtered, acidified and decarbonated, into the Shimadzu TOC-5000 analyser. The sample, carried by pure oxygen gas (99.999%), is passed through a catalyst (Al/Pt, 0.5%) at high temperatures (680°C) and converted to CO_2 gas. The latter is quantitatively measured by an Infrared Gas Analyser (IRGA) (i.e. LiCor). The data produced is recorded onto a PC-based integration system.
Through the use of an Antek 705D Nitrogen Specific Chemiluminescence Analyser, Total Dissolved Nitrogen (TDN) in the seawater sample can also be determined. The nitric oxide

radicals produced from the combustion of nitrogenous compounds in the sample in an oxygen atmosphere at 680°C, react with ozone to produce excited nitrogen dioxide species, which emit quantifiable energy as they return to their ground state. Nitrogen based nutrient data is used to calculate the concetration of DON from the TDN measurements (DON = TDN- Inorganic Nitrogen).

NUTRIENTS: Seawater was collected from the CTD bottle into Nalgene plastic bottles (50ml) that were prewashed and acid-rinsed (5%HCl). Immediately after collection the bottles were stored in a freezer at -20°C. The samples will be analysed at the PML by Malcolm Woodward.

SAMPLES COLLECTED

Samples were collected from the CTD, the surface underway supply and the bottom lander sampler (see Table I).

Station	Latitude	Longitude	Depth, m	DOC/TDN	Nutrients
1 (offshore)	37 35 35 N	10 37 99 W	4500	3000m	none
2 (S transect)	42 10 10 N	09 18 81 W	200	4 depths	4 depths
3 (S transect)	42 09 N	09 27 W	1000	12 depths	12 depths
4 (S transect)	42 09 N	09 44 W	2250	20 depths	15 depths
5 (S transect)	42 10 N	09 35 W	2000	8 depths	8 depths
6 (S transect)	42 08 N	09 31 W	1550	9 depths	9 depths
7 (S transect)			600	9 depths	9 depths
8 (S transect)	42 09 N	09 20 W	230	6 depths	6 depths
9 (S transect)	42 08 89 N	10 30 01W	2700	22 depths	11 depths
10 (Canyon)	39 29 85 N	09 55 56 W	3400	21 depths	none
11 (Canyon)	39 34 01 N	10 09 93 W	4100	7 depths	none
12 (offshore)	36 33 05 N	08 30 04 W	2100	20 depths	none
Underway	N, P and S transects		surface	27samples	3 samples
Bottom lander (S transect)	10, 20 and 40 cm from the bottom		1900	1 sample	none

There was not a chance to work up the preliminary data onboard.

5.2.2.4 Radionuclides (Sabine Schmidt)

Water column
The objectives are:
- to estimate particle residence time in intermediate nepheloid layers and in surface waters, using ^{234}Th ($t_{1/2}$= 24.1 d) : ^{238}U and ^{228}Th ($t_{1/2}$= 1.9y) : ^{228}Ra activity ratios;
- to determine scavenging intensity onto particles and its variations within the margin, using ^{230}Th / ^{231}Pa.

For ^{234}Th and ^{228}Th measurements, each 40-liters seawater sample is filtered trough a 0.45 µm filter. Due to the short half-life of ^{234}Th and to avoid significant ingrowth corrections, the separation of ^{234}Th from its ^{238}U parent is carried out on board within 24 hours after seawater collection. For analysis, ^{229}Th yield tracer and 120 mg Fe (as $FeCl_3$) are added to the dissolved sample after acidification to pH 2. After spike equilibration, $Fe(OH)_3$ was precipitated by adding NH_4OH to pH 7. After recovery of the precipitate, the separation of ^{234}Th and ^{238}U is obtained by

passage through an anion exchange column (Dowex 1x8, 100-200 mesh) under 8N HCl conditions.
Within two months after the cruise, particulate ^{234}Th will be directly measured on the filter with a low background-high efficiency detector. Purification of dissolved ^{234}Th will be achieved prior determination of chemical yield, derived from ^{229}Th, and dissolved ^{234}Th activity by g-counting.
On board Radium is extracted from seawater by coprecipitation with $BaSO_4$. At the lab precipitates will be rinsed and dried, prior measurements by gamma spectrometry within 6 months after the cruise.
Sampled CTD / depth (m): 004 (40, 100, 150), 010 (40, 100, 150), 019 (100, 190, 350), 022 (130), 033 (40)

For ^{230}Th / ^{231}Pa determination, ^{229}Th / ^{233}Pa yield tracers and 80 mg purified Fe are added to each total 20-liters seawater sample. The precipitate is recovered on board. Further measurements will be done by mass spectrometry at the Lamont, next autumn.
Sampled CTD / depth (m): 007 (100, 250, 500, 650, 800, 900), 015 (300, 1000, 1500, 1700, 1800), 033 (500, 1100, 1600, 2000, 2500).

Sediment
By using selected isotopes with different half-live provides, we will focus on the characterisation of sedimentation pattern of the Iberian margin on short-time scale. With a multitracer approach (i.e. $^{234}Th_{xs}$ (24.1 d), $^{228}Th_{xs}$ (1.9 y), $^{210}Pb_{xs}$ (22.3 y) and ^{137}Cs (30 y)), we will better constrain the determination of the bioturbation rate coefficient, and in particular test the assumption of steady state at the sea-sediment interface. The occurrence of $^{234}Th_{xs}$, when observed in the uppermost layer of cores will indicate recently deposited particles.
Sampled sediments from box-corer: BC009-2 / multicorer: MC011-9, MC020-7, MC024-18, MC25-5, MC26-4.
On board, each core is sub-sampled, sliced each 0.5-cm from 0 to 5 cm, then each 1-cm in the deeper part of the core. At the laboratory, sediments will be drying at 60°C, then aliquots of 2-12 g are measured by gamma spectrometry. The top of each cores (2-3cm) will be measured within 1 month after the cruise in order to detect ^{234}Th in excess. The detectors in use are two well-type high efficiency germanium crystals (215 and 430 cm^3). Measured radionuclides will be: ^{210}Pb, ^{226}Ra, ^{234}Th, ^{228}Th, , ^{228}Ra, ^{137}Cs and ^{40}K (expressed in %K).

5.2.3 Fluxes as measured by moored sediment traps and suspended Particle inventories (Rolf Peinert, Kerstin Nachtigall)

In the framework of OMEX we determine the flux of particles at the northern Iberian Margin and interpret these fluxes in relation to the productivity and physical regime, also in comparison to the differing region at the Goban Spur. The main objective of our work during METEOR cruise 43/2, thus, was to gather information on winter non-upwelling conditions off NW Spain, and in detail:

- to obtain time-series recordings of sediment trap and current data to characterise vertical and horizontal fluxes of particulates at and across the continental margin. For this purpose deep-sea moorings fitted with automated sediment traps, current meters and transmissiometers had been deployed during a cruise with R/V PELAGIA in summer 1997 and recovered & redeployed (fitted additionally with *in situ* pumps) during the POSEIDON 327/1 cruise in late winter 1997. Final recovery of these mooring was planned for this cruise .
- to characterize suspended particle inventories in upper ocean layers off NW Spain for comparison with trap and in situ pump samples and as a contribution to describing seasonality of sources for particle flux. Particle load and composition in Intermediate Nepheloid Layers

(INL) were to be sampled for a better assessment of their relative impact on fluxes measured by sediment traps at the continental slope.

Sediment trap moorings

Two moorings (IM 2-2 and IM 3-2) had been deployed along a transect at 42°38'N at water depths of 1500 and 2245 m in March 1998 (positions in table below). The upper part of **mooring IM 2-2** had been found adrift and had been retrieved by a fishing vessel far to the north of the initial mooring position in October 1997. The sediment trap and *in situ* pump deployed at ~600 m depth had functioned well. The *in situ* pump (Baltec GmbH, Germany) had been programmed to filter sea water onto 47mm ∅ polycarbonate filters at the mid-time of the trap collection interval. Samples were poisoned *in situ* with mercuric chloride and stored water-tight until recovery. The respective trap and pump samples were handed over to IFM and are processed currently. A full set of samples, thus is at hand for the upper (~600 m) horizon from mooring IM 2-2. During the METEOR cruise the remaining (deeper) part of this mooring (sediment trap, pump, current meter/transmissiometer) was searched and found at its original position on 4th January. Release was successful according to responses by both acoustic releasers. The array, however, failed to ascend to the surface, possibly due to a lack of buoyancy, and at a scale of hours upon release there were no signs for any horizontal drifting of the array. It has to be considered as a lost.

Recovery of **mooring IM 3-2** took place under quite unfavorable weather conditions and state of the sea on 4th January. The whole array including all instruments could be recovered safely, however, due to the expert assistance of the crew of R/V METEOR. The deepest trap had malfunctioned, and flooding of the pressure housing was to be noted for the deepest current meter. The *in situ* pump deployed at 645 m provided 5 filters as pre-programmed but had failed to continue operation thereafter, and corrosion of the steel pressure housing was noted. A full set of 40 sediment trap samples and current meter/transmissiometer data from the two shallower depth horizons (~600 m and ~1000 m depth, see table below) was obtained from this mooring. First visual inspections of the trap samples revealed that fluxes at the mooring site had been substantial during selected sampling intervals and that variability is coupled to seasonal changes in the export regimes in the overlaying waters (related to seasonality in upwelling).

Table: details of sediment trap moorings

Mooring	Water depth	Position	Instrument depth	Instrument
IM 2-2	1500 m	42°38´N, 009°42'W	580 m	Sediment trap
			600 m	Current meter
			650 m	In situ pump
			1050 m	Sediment trap
			1070 m	Current meter
			1120 m	In situ pump

Mooring	Water depth	Position	Instrument depth	Instrument
IM 3-2	2245 m	42°38´N, 010°02’W	570 m	Sediment trap
			590 m	Current meter
			645 m	In situ pump
			1050 m	Sediment trap
			1070 m	Current meter
			1750 m	Sediment trap
			1770 m	Current meter

Suspended particle inventories

Hampered by foul weather and time constraints a reduced water column sampling programme was conducted at 7 stations in the OMEX Box off NW Spain, with a focus on Transect S. Stations covered the shelf regime as well as those of the slope and of the adjacent deeper waters. 50 samples were taken *in toto* predominantly from the productive upper 200 m layer using the CTD rosette,. Between 2 and 12 l were filtered onto GF/F or Cellulosis Nitrate filters and stored at –20 °C for later land-based determinations of dry weight, carbonate, POC, PON, Opal and d^{15}N. These samples will contribute to the basis for seasonal comparisons of suspended matter with sinking particles at the Iberian Margin. For the same reason suspended particles in intermediate nepheloid layers (INL) were sampled at 2 stations on Transect S for analyzing possible differences in particle composition relative to waters above and beneath.

Table: Stations sampled for water column particle inventories

Station	water depth	sampled depths (m)
7-2	225 m	10, 30, 60, 100, 150
8-2	1050 m	10, 30, 60, 100, 150, 200
10-2	2265 m	10, 30, 60, 100, 150, 200, 600, 1000, 1700
11-2	1900 m	10, 30, 60, 100, 150
13-2	950 m	100, 200, 350
17-1	233 m	200
24-1	2762 m	10, 30, 60, 100, 150, 200, 300

5.2.4 Benthic Ecology

5.2.4.1 The benthic resuspension loop (Laurenz Thomsen,Volker Karpen)

One of the aims of the Benthic subproject within OMEX is to evaluate the role of biological processes in cycling of particulate organic matter within the benthic boundary layer (BBL). Our hypothesis is that lateral mass fluxes of particulate matter exceed the vertical fluxes, byepass the vertical transport pathway and that aggregates in the BBL play an important role in these fluxes. To understand and quantify these transport processes, both laboratory and field studies are required to link hydrodynamics with particle and bed formation. Advective near-bed fluid flow imports both particles and solutes from sources upstream (in addition to those arriving from above) that can serve as food (and fuel) for benthic communities. Through the coupling to the local ecosystem, more or less nutrient-rich, reprocessed or remoulded particles such as faecal

wastes or detritus, and dissolved metabolites are subsequently exported (moved downstream). For a model as well as calculations of the mass fluxes associated with this bed-flow-biology interaction, several important particle and hydrodynamic parameters need to be determined: the bottom stress (t), expressed as friction velocity (u_*), the turbulence intensities and the mean local horizontal speed together with the controlling variables of sediment transport: the critical erosion stress (t_e) and the particle settling velocity (w_s).
The goal of this Meteor cruise was to determine these key parameters at the Vigo transect. In order to determine the horizontal particle fluxes, bottom water samples in the lowermost watercoulmn (0-100 cm a.b.) were taken with the BIOPROBE system and the erosion resistance of slope sediments was determined. On a total of 6 stations between 200 and 4000 m water depth, onboard measurements with an erosion chamber were carried out and sediment samples were taken for laboratory flume experiments on biodeposition and bioerosion of slope sediments. Priliminary results showed that flow velocities at 40 cm height above bottom at the slope varied between approximately 2 and 15 cm/s and were either directed downslope or along slope. Benthic boundary layer (BBL) aggregates > 100 µm in diameter were resuspended under flow conditions > 8 cm/s and the critical shear velocity of the cohesive slope sediments increased with depth to u_* of 1.4 cm/s. First deployments of a calibrated sediment trap, connected to BIOBROBE at 1.5 m height a.b. (in cooperation with the Technical university Hamburg-Harburg) will allow the determination of in situ particle size/ settling velocity relationship in the BBL. With a newly developed particle camera/Laser - Schlieren optic, near bed flow conditions and effluxes of dissolved substances will be measured.

5.2.4.2 Phytopigments in the sediment (Marc Lavaleye)

The objective to participate the cruise was to collect sediment samples for the (HPLC) analysis of algal pigments. Because algal pigments, and specifically free chlorophyll-a, belongs to the category of very labile organic compounds it serves as a tracer for the fresh organic matter. Analysis by means of HPLC not only allows detection of chlorophyll and its degradation products but also of accessory carotenoid pigments. Because several carotenoids are highly specific for algal taxa they provide a clue on the source of the phytodetritus present near the sea floor. Also the short term mixing by benthic fauna can be resolved by means of the downcore distribution of pigments. For this purpose we have sectioned the sediment samples down to 10 cm.

Method

Sediment samples for study of the vertical pigment profiles were collected with a multi-corer. Two cores (∅ 10 cm) from as many multicores as possible were sliced in a cold lab (4°C) in the following layers: 0-1 mm, 1-5 mm, 5-10 mm, 10-15 mm, 15-20 mm, 20-25 mm, 25-30 mm, 30-35 mm, 35-40 mm, 40-45 mm, 45-50 mm, 50-60 mm, 60-70 mm, 70-80 mm, 80-90 mm and 90-100 mm. Cores were slicesed as acurate as possible with the help of adjustable piston and 5 and 10 mm ring. The fluid upper one millimeter of the sediment was partly sampled with a syringe. All phytopigment samples were stored at -20°C and are taken to the NIOZ on dry ice for HPLC analysis.
At five stations we were able to collect samples:

MC 11-1	1952m
MC 20-7	216m
MC 24-1	2776m
MC 25-3	3554m
MC 26-3	2893m

The first three station are situated on the OMEX S-transect (42° 09' N), while the last two were taken in the Nazaré Canyon (39° 29' N). The cores from the first two station were shared with

Sabine Schmidt. At two other stations the multicore failed to bring up any samples (first benthic station, 2300m), or did not yield enough samples (sta. 27, 4100m).

5.2.4.3 Sediment oxygen demand, ATP and food quality (Anja Kähler, Uli Franke, Florian Peine, Gerhard Graf)

Downslope transport of organic particles across the shelf edge is a major factor to determine benthic biomass and activity in continental slope habitats. The major objective during this cruise was to investigate the Vigo-Profile (OMEX S-transect) as an example for a very narrow shelf and to compare the results with measurements in the Nazaré-Canyon, where an intensive focusing of downslope transport can be expected.

Benthic activity was described in terms of sediment oxygen demand, whereas biomass was measured as macrofauna and ATP-biomass. To characterise food quality C/N ratios and Chlorophyll a were measured in the sediment. The latter will later also be used as natural tracer for the modelling of bioturbation. On the Vigo transect stations 11, 20, 24 and on the Nazaré-Canyon stations 25, 26 and 27 were sampled.

Method

The sediment samples were taken with a multiple-corer for Chl.a, C/N, POC, ATP, water content of the sediment, and core-incubation for SOD, or with a box-corer for macro-fauna and grain-size analysis. Macro-fauna was sieved with a 0,5 mm sieve and fixed with buffered formaldehyde (4%).

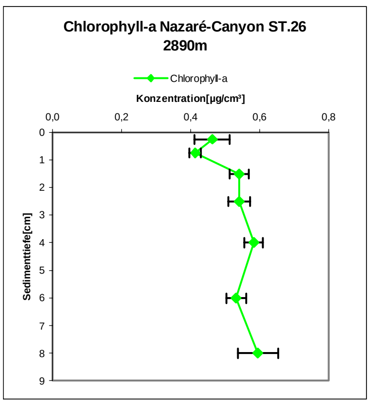
All sediment samples (for: C/N, Chl.a, POC) are from the upper most 9cm of the sediment. The cores (Ø 10cm) were sliced in the cold lab (4°C) in 7 horizons: 0-0,5cm, 0,5-1cm, 1-2cm, 2-3cm, 3-5cm, 5-7cm and 7-9cm. After slicing the sediment was homogenised by stirring and kept frozen (-20°C). All samples were taken home on dry ice for later analysis, only Chl. a measurements were carried out on board using a fluorometer after extraction with 90% acetone.

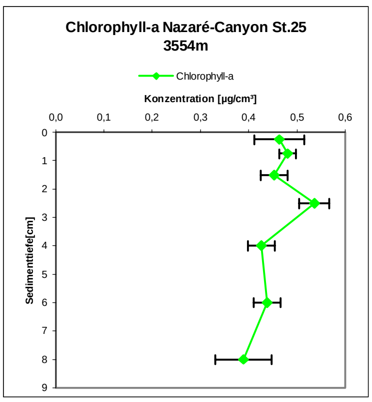
The sediment for ATP-measurement was stabilised in phosphate-buffer and boiled in glycine-buffer for 30min. at 90°C. The samples were kept frozen (-20°C). ATP-measurement will be done at home.

Oxygen consumption was measured on board by Winkler-titration after whole core incubation for at least 12h in an incubation-box at in situ temperature.

Preliminary Results

Fig. xy depicts high chlorophyll a concentrations in the Nazaré-canyon, reaching more than 0.4 µg cm^{-3} in the deepest station investigated. All values were significant higher as compared to the Vigo transect suggesting that the canyon concentrates the downslope transport and works as a huge sediment trap. The shape of the profiles indicate intensive bioturbation which will not be explainable by diffusion analogy, but will need a significant non-local contribution.





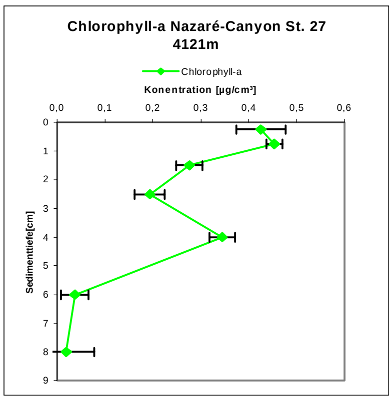


Fig. xy: chlorophyll a in sediments of the Nazaré-canyon

Fig. xy shows the sediment oxygen demand at the Vigo-profile at Stations 11, 20 and 24. The highest values of 4,4 mmol $O_2m^{-2}d^{-1}$ are observed at the shelf station (20) at a depth of 217m, at Station 24 the oxygen demand is 2,3mmol $O_2m^{-2}d^{-1}$ (2765m) and at Station 11 it is 1,9mmol $O_2m^{-2}d^{-1}$ at a depth of 1952m.

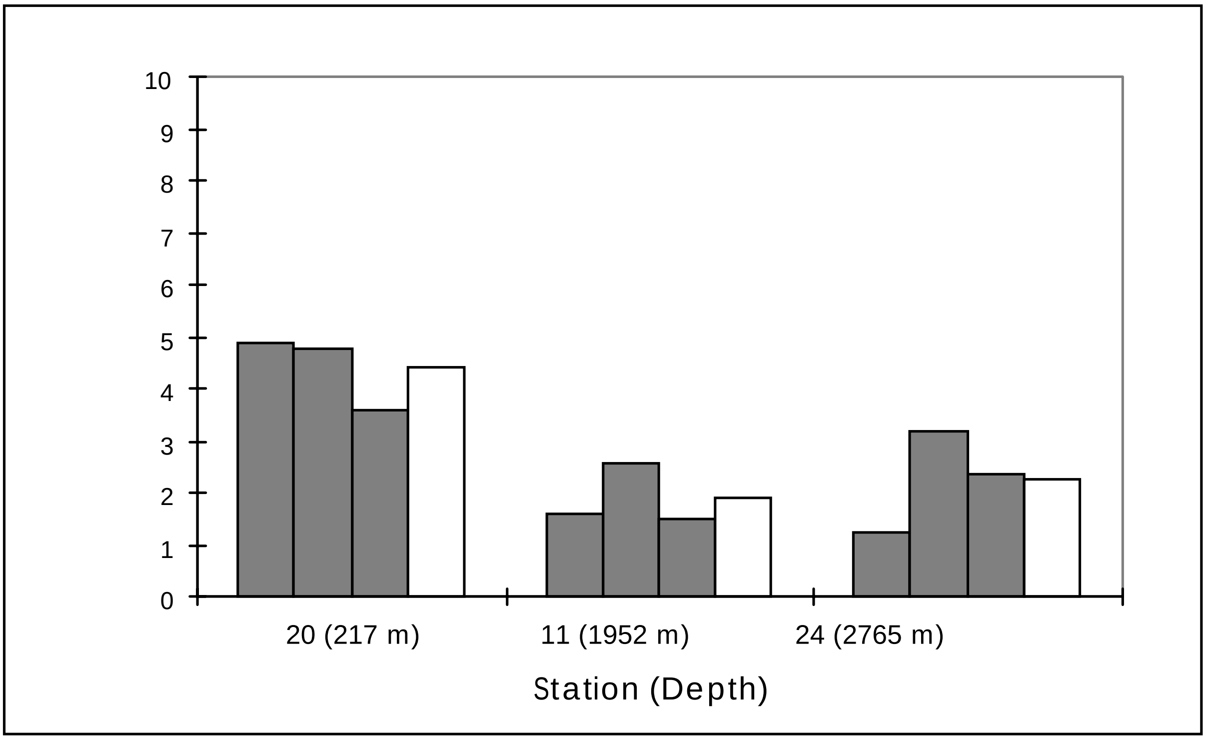


Fig. xy: Sediment Oxygen Demand on the Vigo-profile. The white bar gives the mean value.

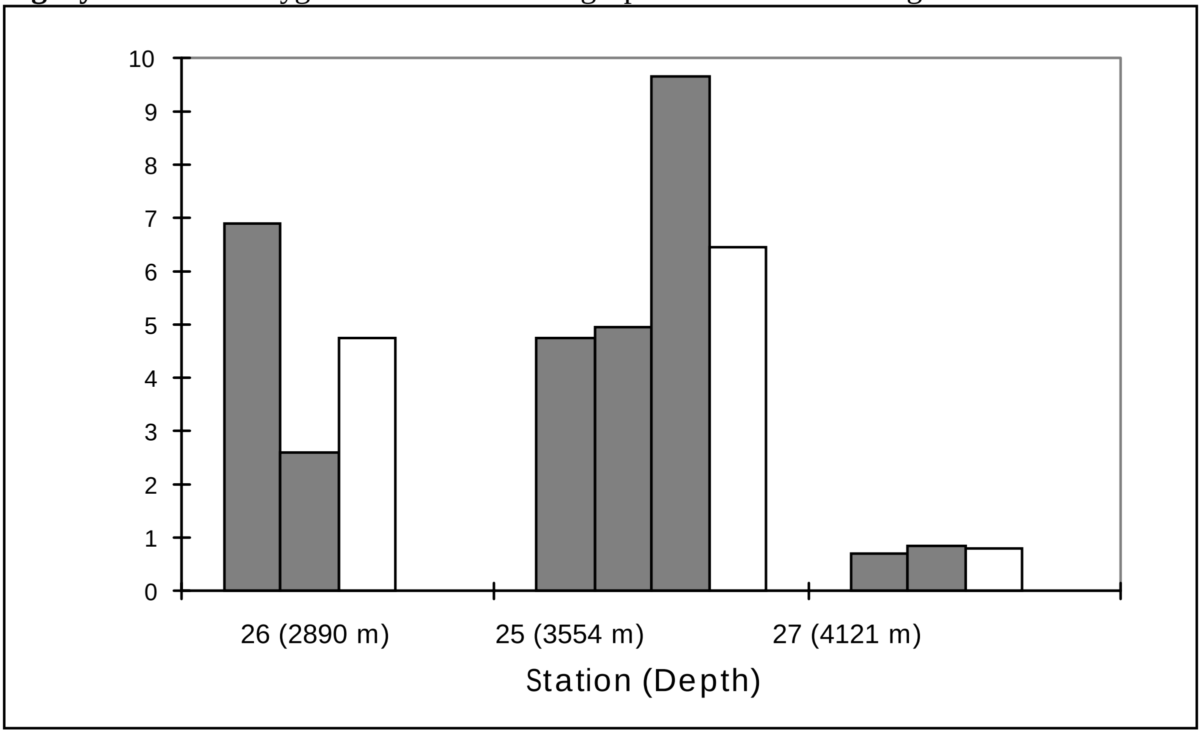


Fig. yx: Sediment Oxygen Demand on the Nazaré-Canyon. The white bar gives the mean value.

Fig. yx depicts that the sediment oxygen demand in the canyon is extremely high. Especially at station 25 one of the highest values ever reported for such a water depth was measured.

5.2.4.4 Macrofauna and Meiofauna (João Luís da Silva Cúrdia)

The study of the structure of benthic macrofauna communities is very important to understand the carbon and other nutrient cycles. As an OMEX II project objectives, benthic comunities are to be studied, aiming a better knowledge of the role of some characteristic parameters regarding the development of deep sea benthic animal communities. The main objective of this work is to collect winter data from the Vigo profile in order to establish a seasonal change pattern in biodiversity and community structure, comparing winter data with summer data (previously sampled in another OMEX II cruise). In addition to this, we are looking forward to compare the composition and structure of benthic communities from Vigo (Spain) and the Nazare (Portugal) canyon. Since the depth seems to be the major factor affecting benthic comunities, two transects were established, one in Vigo and the other in Nazaré. Four stations at different depths (2768 m, 2323 m,1951 m and 216 m) were analised in Vigo transect. In Nazare canyon, three stations at different depths (4141 m, 3514 m and 2894 m) were sampled.

In order to study the different type of benthic macrofauna communities a boxcore of 50 x 50 cm was used. In each boxcore a sediment sample was collected in a small box for future determination of Total Organic Matter and grain size analysis. This small box was frozen immediately at –20°C. The redox potential of the boxcore was measured after 2 minutes at a sediment depth of about 4 cm. The upper 15 cm of the boxcore were sliced in 5 layers, 0-1cm, 1-3 cm, 3-5 cm, 5-10 cm and 10-15 cm. These layers were then sieved with a 500 µm sieve for macrofauna .

A subcore (from the boxcore) of 10 cm diameter was used for meiofauna determination. Whenever possible, another subcore of 10 cm diameter was taken from another boxcorer as a replicate for meiofauna (in the Nazare canyon this second subcore was not possible to take).The subcores of 10 cm were also sliced in the 5 layers previously specified and, in each layer, the redox potential was measured. The layers of meiofauna samples were stored in a buffered 4% formalin solution without being sieved. The 500 µm sieved samples for macrofauna were also stored in a buffered 4% formalin solution. All analyses will be carried out in our home instituion.

5.2.4.5 Uptake and mixing of algal carbon by benthic organisms (Leon Moodley, Hilda Bouma)

The fate of phytodetritus shortly after its deposition is poorly understood in terms of which organisms have early access to it and the rates by which it is displaced and decomposed within the seabed. Understanding the fate of labile organic matter arriving at the seafloor is of great importance as it is the primary driving force of the benthic system. It has an impact on the magnitude and timing of various benthic fluxes and mineralisation and life strategies of the benthic organisms. In this cruise, we addressed this question by conducting short-term experiments (24-48 hrs), in which we added ^{13}C enriched algae to sediments in benthic chambers maintained on deck at bottom water temperature. The uptake or mineralization of the added algal carbon will be reflected either in the $\delta\,^{13}C$ of different faunal components or in the $\delta\,^{13}C$ of the CO_2 produced in the overlying waters. A detailed study was done only at the OMEX site having a water depth of 261 m. Less elaborate analysis were done at the 1950 m deep OMEX station and at the 3500 m deep Canyon station (see Table 1).

Method

Upon addition of 15 mg of algal material and following a period of incubation, sediment or water samples were taken the following analysis:

1. The response of the benthic system as a whole was examined by measuring SOC and CO_2 production in benthic chambers (14 cm inner diameter) fitted with oxygen probes and stirrers. The oxygen consumption was recorded on a data logger and the overlying water was sampled for CO_2 content. The overlying water was acidified in cap vials having a 3 ml nitrogen headspace. The CO_2 content in the headspace will be analyzed with a Carlo Erba high resolution MEGA 5340 gas chromatograph.

2. Faunal and bacterial uptake of algal carbon. The fauna > 300 µm were or will be isolated from different sediment intervals down to 6 cm. Sediment from these intervals were also collected for the isolation of bacterial biomarkers. The $\delta^{13}C$ of these components will allow us to determine the distribution of the labeled algal carbon over the different components of the benthic system.

3. Bioturbation. Transport of highly reactive organic matter from the sediment-water interface to the deeper layers will be examined through analysis of bulk $^{13}C_{org}$ in the different sediment intervals. Sediments were sampled in centimeter slices down to 12-14 cm. An attempt will also be made to measure the $\delta^{13}C$ of CO_2 produced in sediment slurry incubations (see below).

In addition to this we sampled sediments down to 13 cm in centimeter intervals for long-term sediment slurry incubations; to measure CO_2 production in the headspace above sediment-water slurries. A volume of 10 ml sediment was transferred into 70 ml glass incubation bottles (Chrompack), diluted with 10 ml filtered seawater and sealed with screw caps provided with rubber septa. Headspaces were purged with N_2 for the anoxic incubtions and with synthetic air having no CO_2 for the oxic incubations. The CO_2 production in the head space of these long-term sediment slurry incubations will provide insight into the organic carbon mineralizatin rates (the amount of labile organic matter present in the sediment). The utility of this method in estimating carbon mineralization rates in deep-sea sediments can be assessed when results are compared to mineralization rates measured by Graf et al. through SOD measurements.

Table 1. List of activities at each station.

	OMEX station 216 m	OMEX station 1952 m	Canyon station 3500 m
Sampling	Boxcore	Multicore	Multicore
Sediment oxygen consumption (SOC)	Yes	No	No
CO_2 production measurements	Yes	No	No
Fauna > 300 µm	Yes	Yes	Yes

Bacterial biomarkers	Yes	Yes	Yes
Bioturbation (Bulk $^{13}C_{org}$)	Yes	Yes	Yes
Long-term sediment slurries	Yes	Yes	Yes

Preliminary Results

The greatest concern with deck incubations is the effect of pressure changes on the benthic community. Organisms from both the 216 and 1952 m deep stations remained alive and active. However, although a few polychaetes were still alive after 2-3 days, organisms from the 3500 m deep canyon station showed clear signs of decay after 3 days. Whether organisms indeed continued normal activities will only be evident after isotope analysis.

Sediments from the canyon were distinctly different from the OMEX sites that were characterized by presence of foram and pteropod shells even more at the 1950 m station. Sediment from the canyon station was composed mainly of plant debris and pieces of charcoal.

At the 216 m station, a clear difference in SOC was evident before and after the addition of algal material. This was evident following an incubation period of 24 hours and this suggests that the benthic response may be very rapid.

5.2.4.6 The Deep Water Coral Settlement Experiment (Marc Lavaleye)

During the Dutch OMEX cruise in May-June 1998 with the RV.Pelagia a settlement lander was deployed at a station G100 (780m) at the Galicia Bank in an area where the cold water corals *Lophelia pertusa, Madrepora oculata, Desmophyllum cristagalli* are abundant. The lander consists of a frame with 18 plates (45x45cm) and a large sediment trap. The plates are either from PVC, polypropyleen or ethyleen. To each plate, tiles (glazed and unglazed) and oyster shells are attached in a random order. This experiment is to investigate where (substrate preference) and when cold water corals settle, and how quick they grow. This study forms an addition to our current growth studies on *Lophelia* and *Madrepora* skeletons. It will also contribute to the discussion on how quick cold water corals can recover from damage caused by commercial fishing activities. In order to find out whether any bio-erosion by microborers occurs during the deployment period, two pieces of iceland spar had been attached to the lander (cooperation with John Wilson, Holloway University, London).

During a second expedition with the RV Pelagia in September 1998 the lander was succesfully recovered. After the replacement of 9 out of 18 plates the lander was re-deployed at the same location. An inspection of the plates and attached tiles and oyster at that time did not reveal an abundant growth of epifauna, though small white tubes of polychaetas were seen in small numbers at most of the tiles and oysters. There were, however, no macroscopical traces of coral settlement detectable.

During this Meteor cruise it was the objective to recover the frame and end the experiment. However, because of the bad weather, we refrained from recovering the settlement frame. The chances of loosing or damaging it during recovering and the risk for the deck crew were too great. The only thing done on 5 Jan. 1999 was checking if the frame was still there by waking up one of the releases. It responded without any problems. Immediately afterwards the ship sailed to a more southern transect to escape the bad weather condition, and did not return anymore to the principal OMEX transect. Another possibility has to be found to recover the frame this year.

5.2.5 Sedimentology (Carla Garcia)

Surficial Sediments

The first 3 cm of surficial sediment was taken from each sample to be analysed, among other sedimentological parameters, for grain size, mineralogical composition and clay mineralogy. The main objective of this work is to perform the sedimentary cover map of the OMEX area including the shelf.

With this study we also pretend to understand the diagenetic processes occurring in the area, and to have an idea of the sedimentary dynamics to try to reach to the main depocenters in this area.

In the Nazare Canyon samples were also taken for the same kind of analysis, to be used as a complementary information for other partners.

The samples were collected using a boxcore (BC) and a multicore (MC).

The following stations were performed:

Station	Latitude	Longitude	Deep (m)	Description
BC009-2	42º 08.5'N	9º 46.6'W	2323	Mud
BC011-4	42º 10.5'N	9º 36.0'W	1954	Fine Mud
BC020-2	42º 09.0'N	9º 18.7'W	216	Sandy Mud
MC021-1	42º 07.0'N	9º 18.8'W	206	Sandy Mud
MC022-1	42º 11.0'N	9º 18.8'W	222	Sandy Mud
BC024-12	42º 09.0'N	10º 30.0'W	2764	Muddy Sand
BC025-3	39º 29.7'N	9º 55.4'W	3510	Fine Mud rich in organic matter.
BC026-2	39º 29.0'N	9º 45.1'W	2894	Fine Mud
BC027-1	39º 34.0'N	10º 10.3'W	4121	Silty-clay

Kasten Core

During the cruise two Kasten cores were performed, one in the Omex area and other on the Nazare Canyon. Unfortunately the last one failed and the core bent.

The main objective for the study of these cores is trying to identify small climatically changes. X-Ray studies to identify structures in the sediment, grain-size, clay mineralogy, mineralogical composition, heavy-minerals, heavy-metals, the study of foraminifers, and ^{14}C dating are some of the works to be performed in this core so we can achieve our main proposes.

Station	Latitude	Longitude	Deep (m)	Length
KC024-19	42º 09,0'N	10º 30,0'W	2761	2.16 m
KC027-3	39º 33.9'N	10º 09.9'W	4121	Failed

As all the analysis in the surficial sediments and on the Kasten core will be performed on the laboratory it's now impossible to take any conclusions.

Parasound

Parasound profiles are precious for sediment interpretation. They can help to define sediment changes and rock outcrops, contributing to a more rigorous cartography. The sampling of surficial sediments in these transects is most useful to accurate parasound results. The files from the parasound were store in digital way.

The following transects were performed:

Date	Hour	Start	End	Dist.	Ship Vel.
02/01/99	23:09	42 40.0 N/10 05.2 W	42 37.2 N/09 59.8 W	4 sm	7,0 kn
	23:45	42 37.2 N/09 59.8 W	42 37.5 N/09 30.3 W	22 sm	=
03/01/99	03:02	42 37.5 N/09 30.3 W	42 27.5 N/09 30.0 W	10 sm	=
	04:32	42 27.5 N/09 30.0 W	42 27.5 N/10 00.0 W	22 sm	=
	07:34	42 27.5 N/10 00.0 W	42 32.3 N/10 00.0 W	5 sm	=
	19:12	43 00.0 N/10 20.0 W	43 00.0 N/09 37.2 W	27 sm	=
04/01/99	00:06	43 00.0 N/09 37.2 W	42 52.1 N/09 37.0 W	8 sm	=
	01:53	42 52.1 N/09 37.0 W	42 37.5 N/09 30.0 W	15 sm	=
11/01/99	06:14	39 29.8 N/09 55.5 W	39 31.8 N/09 48.5 W	12 sm	5,0kn
	08:00	39 31.8 N/09 48.5 W	39 31.7 N/09 46.1 W		=
	08:21	39 31.7 N/09 46.1 W	39 29.0 N/09 45.1 W		=

5.2.6 Determination of the net total radiation and atmospheric turbidity at sea (Hein Dieter Behr)

Information about the spatial and temporal distribution of the net total radiation and its components at the sea surface as well as atmospheric turbidity are one of the most important parameters in resolving numerous meteorological and oceanographic questions. Therefore during the cruise the following radiation components were recorded: direct solar radiation, sunshine duration, global solar radiation and UV-B global solar radiation as well as longwave thermal radiation of the atmosphere. Additional components necessary to establish a radiation balance: reflected solar radiation and ocean surface radiation are computed using numerical models successfully tested on former research cruises in the Atlantic, Behr (1990).

As atmospheric turbidity influences global solar radiation on its way through the atmosphere, the knowledge of this quantity is essential. Atmospheric turbidity is expressed by turbidity coefficients as follows:
T_L: Linke-turbidity-coefficient, describing all radiative processes in the whole solar spectrum,
T_s: turbidity-coefficient, describing all radiative processes in the **s**hort-range part of the solar spectrum ($0\ \mu m < \lambda < 0.63\ \mu m$), giving information about the dust in the atmosphere,
T_r: turbidity-coefficient, describing all radiative processes in the **r**ed part of the solar spectrum ($0.62\ \mu m < \lambda < 2.8\ \mu m$), giving information about the water-vapour-content in the atmosphere.

The coefficients T_L, T_s, and $T_r \equiv T_x$ can be computed by:

$$I_x = I_{0x} \exp(-T_x \cdot m \cdot \delta) \qquad (1)$$

with:
I_{0x}: extraterrestrial solar radiation received from a surface normal to the beam of the sun. Its quantity depends on the distance sun - earth only,
I_x: direct solar radiation received from a surface normal to the beam of the sun, e.g. measured with a Linke-Feussner-Actinometer,
m: optical pathlength, dependent on the solar elevation angle.
δ: optical thickness of the atmosphere.
Simply spoken T_x equals the number of clear Rayleigh-atmospheres which had to stack up one on the top of the other in order to correspond to the atmosphere in which measurements were done.
The data set of numerous measurements of direct solar radiation I done with a Linke-Feussner-Actinometer revealed the spatial and temporal variation of the atmospheric turbidity during the cruise. As a first result the daily courses of T_L, T_s , and T_r along the transect from Las Palmas d. G. C. via the mooring stations at 42°N/9.5°W to Cádiz will be shown here. As R/V METEOR worked nearly the whole time in cold fresh air coming from the dust-free Northwestern Atlantic Ocean the Linke-turbidity coefficient was about 2.5 during sunrise and sunset and increased to 4.8 during noon, representing clear unloaded air. T_s , and T_r correspond to this findings, they are low too: T_s =1.5 to 2.0 and T_r = 7 to 12. But there was a short change in the airmasses reaching R/V METEOR during January 4 to 6: southwesterly winds transported airmasses with high humidity in all layers and loaded with dust particles from the Morocco-area. These particles swell and adhered together during their transport to the working area causing an increase of T_L. From 6,5 during sunrise and sunset and 8.5 during noon. T_s , and T_r increased simultaneously: T_s about 3.0 and T_r = 30 t0 37. These data characterize an industrial area. These findings correspond to former results found by Behr (1990, 1992).

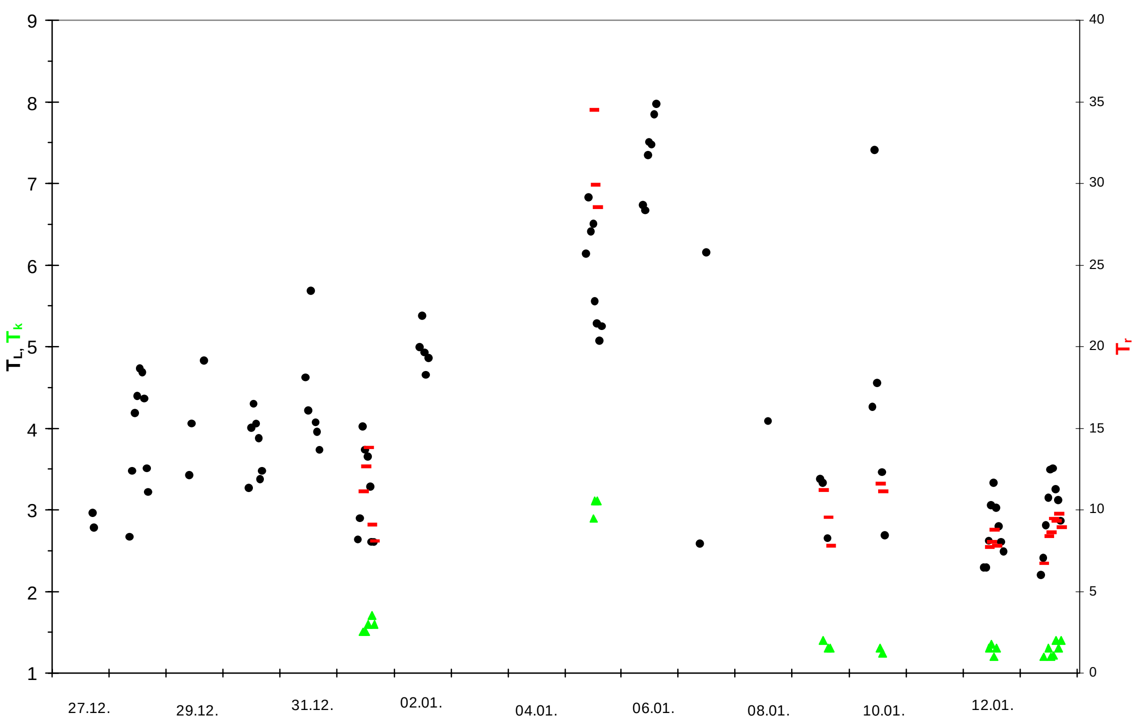


Fig. 1. Daily courses of the turbidity coefficients T_L (dots) T_k (triangles), and T_r (dashes) during (M43/2)

6 SHIPS METEOROLOGICAL STATION

6.2 Weather and Meteorological Conditions during Leg M43/2 (H. D. Behr)

R/V METEOR left the port of Las Palmas d. G. C. on December 28, 1998 noon steering on a north-easterly course to her first working position at 37°30’N/10°30’W. The first gale centre in the time of this cruise moved eastwards and deepened in the vicinity of the British Isles to a storm centre causing south-west 8 Bft with gusts of 10 Bft and a swell with heights of 6 m and more in our area. For the safety of the ship and the crew R/V METEOR reduced her velocity and reached her working position in the morning of January 1, 1999. The first tests with the CTD-sondes at this position failed because of the swell. In order to save time R/V METEOR sailed to the northern part of the OMEX-region, which is the expected main working area of this cruise. After reaching this area R/V METEOR picked up a mooring at 40°N/9.5°W and tried to do so with another one at 42°N/13.5°W. As this failed due to heavy sea R/V METEOR returned to 40°N/9.5°W processing Parasound observations meanwhile.
The series of storm centres ended in the morning of January 6. The last gale centre influencing the working area of R/V METEOR with southerly winds force 8 Bft and swell with 6 m moved southwards to the Canary Islands. The wind decreased to Southwest 4 Bft and the swell to 1 to 2 m at January 7. There was no weather-influence on station work for two days. A cold front changed at the north-western corner of the Iberian Peninsula (Cape Finisterre) to a low within 12 hours causing northerly winds increasing to 8 Bft with gusts up to 10 Bft. R/V METEOR could put her bow in the wind easily in order to continue station work as wind, swell, and sea were coming from the same direction for the first time. As this low moved quickly to the Balearic Islands the wind calmed down with variable directions up to January, 11. The last low during this leg moved from the Central North-Atlantic towards the coast of Portugal and from here to Morocco causing north-easterly winds force 7 to 8 Bft at first, decreasing to 4 Bft until the end of the cruise.
R/V METEOR reached Cádiz in the late afternoon of January 14, 1999.

7 Lists

7.2 Leg 43/2

Station	UTC	Device	Date	Geographical position Latitude	Longitude	Waterdepth uncorrected (m)	Wire length (m)	Comments
1	09:27	CTD	1.1	37° 35,2 N	010° 38,0 W	4503m	800m	
	12:24 14:06	CTD		37° 35,5 N 37° 35,8 N	010° 38,1 W 010° 38,4 W	4504m	4000m	
2	08:46	Argos-Drifter 1.	2.1	41° 00,0 N	009° 24,9 W	1000m		
	09:22	Argos-Drifter 2.		40° 59,9 N	009° 27,8 W	1210m		
	09:52	Argos-Drifter 3.		41° 01,8 N	009° 27,8 W	1366m		
	10:29	Argos-		41° 01,8 N	009° 25,4 W	870m		

		Drifter 4.					
3	21:03	CTD	2.1	42° 37,8 N 010° 03,8 W	2356m		break off too heavy sea
	23:09	ADCP		42° 40,0 N 010° 05,2 W			profile start rwK 127°
	23:45			42° 37,2 N 009° 59,8 W			course change to rwK 090°
	03:02		3.1	42° 37,5 N 009° 30,3 W			course change to rwK 180°
	04:32			42° 27,5 N 009° 30,0 W			course change to rwK 270°
	07:34			42° 27,5 N 010° 00,0 W			course change to rwK 360°
	08:00			42° 32,3 N 010° 00,0 W			profile end
	15:32	ADCP/		42° 38,8 N 010° 01,9 W			profile start rwK 328°
	19:12	HS / PS		43° 00,0 N 010° 20,0 W			course change to rwK 090°
	00:06		4.1	43° 00,0 N 009° 37,2 W			course change to rwK 180°
	01:53			42° 52,1 N 009° 37,0 W			course change torwK 160°
	04:46			42° 37,5 N 009° 30,0 W			profile end
4	09:16 09:36	hydro-phon	4.1	42° 38,4 N 010° 01,7 W		2300m	mooring IM3/2 released
	12:17			42° 38,4 N 010° 00,5 W			mooring IM3/2 complete on deck
5	15:58	hydro- phone Benthos/ Oceano		42° 39,0 N 009° 42,2 W	1454m		mooring IM2/2 released
	15:39			42° 39,3 N 009° 41,9 W			mooring does not ascend
	18:53	hydro- phon		42° 39,4 N 009° 41,9 W	1459m		mooring still at bottom
	19:00			42° 39,4 N 009° 41,9 W			break off
	19:00	ADCP / PS	4.1	42° 39,4 N 009° 41,9 W			profile start rwK 270°
	08:29		5.1	42° 44,7 N 011° 46,4 W			profile end

Station	Time	Device	Date	Geographical position Latitude Longitude	Waterdepth uncorrected	Wire length	Comments

	UTC				(m)	(m)	
6	09:17	hydro- phon	5.1	42° 45,2 N 011° 46,2 W			break off of the release of mooring OMEX 1
7	02:56	CTD	6.1	42° 10,1 N 009° 18,8 W	221m	200m	
	03:38	CTD		42° 10,1 N 009° 18,8 W	221m	200m	
	04:21	CTD		42° 10,2 N 009° 18,9 W	222m	200m	
8	07:06	CTD		42° 09,0 N 009° 27,9 W	1053m	1000m	
	08:02	CTD		42° 09,0 N 009° 27,9 W	1056m	300m	
	08:54	CTD		42° 09,0 N 009° 27,9 W	1063m	1000m	
9	12:13	MUC		42° 10,0 N 009° 46,9 W	2333m	2343m	failure
	14:15	GKG		42° 08,5 N 009° 46,6 W	2323m	2326m	bottom contact
	16:06	GKG		42° 08,3 N 009° 46,3 W	2314m	2319m	failure
	17:58	GKG		42° 09,6 N 009° 46,8 W	2330m	2339m	failure
	19:48	BWS		42° 09,0 N 009° 46,9 W	2334m	618m	failure
10	21:05	CTD	6.1	42° 09,0 N 009° 44,4 W	2265m	200m	
	21:37	CTD		42° 09,0 N 009° 44,4 W	2266m	150m	
	22:42	CTD		42° 09,0 N 009° 44,4 W	2263m	1700m	
	23:54	CTD		42° 09,0 N 009° 44,2 W	2256m	900m	
	02:12	CTD	7.1	42° 08,8 N 009° 43,7 W	2236m	2200m	
11	04:40	CTD		42° 10,5 N 009° 35,7 W	1942m	1900m	
	05:51	CTD		42° 10,5 N 009° 35,8 W	1945m	200m	
	06:42	CTD		42° 10,5 N 009° 35,7 W	1940m	1400m	
	08:43	GKG		42° 10,5 N 009° 36,0 W	1951m	1951m	bottom contact
	10:06	GKG		42° 10,6 N 009° 36,0 W	1949m	1952m	failure
	11:20	GKG		42° 10,5 N 009° 36,1 W	1951m	1962m	bottom contact
	12:42	GKG		42° 10,5 N 009° 36,0 W	1945m	1954m	bottom contact
	14:27	MUC		42° 10,5 N 009° 35,9 W	1952m	1952m	bottom contact
	16:05	MUC		42° 10,5 N 009° 35,9 W	1947m	1953m	bottom contact
	18:01	BWS		42° 10,5 N 009° 35,9 W	1950m	1973m	bottom contact
12	20:05	CTD	7.1	42° 08,8 N 009° 31,1 W	1576m	1532m	
13	22:16	CTD	7.1	42° 09,0 N 009° 27,5 W	968m	954m	
	23:03	CTD		42° 09,0 N 009° 27,5 W	970m	350m	
14	00:14	CTD	8.1	42° 09,0 N 009° 26,2 W	603m	530m	
15	01:33	CTD	8.1	42° 09,0 N 009° 23,5 W	269m	230m	
16	02:23	CTD	8.1	42° 09,0 N 009° 20,7 W	233m	200m	
17	03:09	CTD	8.1	42° 09,0 N 009° 18,0 W	210m	200m	
18	03:53	CTD	8.1	42° 09,0 N 009° 15,4 W	187m	178m	
19	04:37	CTD	8.1	42° 09,0 N 009° 13,0 W	172m	115m	
	05:00	CTD	8.1	42° 08,9 N 009° 13,0 W	171m	160m	
20	06:26	GKG	8.1	42° 09,0 N 009° 18,7 W	216m	214m	bottom contact
	06:59	GKG		42° 09,0 N 009° 18,7 W	216m	218m	bottom contact
	07:33	GKG		42° 09,0 N 009° 18,7 W	217m	219m	bottom contact
	08:10	GKG		42° 09,0 N 009° 18,8 W	217m	217m	bottom contact
	08:39	GKG		42° 09,0 N 009° 18,7 W	217m	219m	bottom contact
	09:15	MUC		42° 09,0 N 009° 18,7 W	217m	222m	bottom contact
	09:55	MUC		42° 09,0 N 009° 18,7 W	216m	221m	bottom contact

	10:46	MUC		42° 09,0 N	009° 18,7 W	216m	220m	bottom contact
21	11:49	CTD	8.1	42° 07,0 N	009° 18,8 W	207m	180m	
	12:22	MUC		42° 07,0 N	009° 18,8 W	206m	214m	bottom contact
22	13:19	MUC		42° 11,0 N	009° 18,8 W	222m	233m	bottom contact
23	14:52	BWS		42° 09,0 N	009° 18,8 W	216m	226m	bottom contact

Station	Time UTC	Device	Date	Geographical position Latitude	Longitude	Waterdepth uncorrected (m)	Wire length (m)	Comments
24	20:20	CTD	8.1	42° 09,1 N	010° 30,0 W	2762m	300m	
	20:52	CTD		42° 09,1 N	010° 29,8 W	2763m	30m	
	21:15	CTD		42° 09,0 N	010° 29,8 W	2761m	10m	
	21:51	CTD		42° 09,1 N	010° 29,9 W	2762m	1000m	
	22:32	CTD		42° 09,0 N	010° 29,9 W	2768m	50m	
	23:18	CTD		42° 09,0 N	010° 29,9 W	2763m	2700m	
	01:09	CTD	9.1	42° 09,0 N	010° 30,0 W	2763m	2700m	
	02:40	CTD		42° 09,0 N	010° 30,0 W	2761m	1000m	
	03:33	CTD		42° 09,0 N	010° 30,0 W	2766m	1000m	
	04:25	CTD		42° 09,0 N	010° 30,0 W	2764m	1000m	
	05:19	CTD		42° 09,0 N	010° 30,0 W	2765m	700m	
	07:23	CTD		42° 09,0 N	010° 30,0 W	2766m	2700m	
	09:21	GKG		42° 09,0 N	010° 30,0 W	2764m	2768m	bottom contact
	11:01	GKG		42° 09,0 N	010° 29,9 W	2763m	2765m	bottom contact
	12:59	MUC		42° 09,1 N	010° 30,0 W	2765m	2776m	bottom contact
	13:56	CTD		42° 09,0 N	010° 29,9 W	2762m	200m	
	14:55	MUC		42° 09,0 N	010° 29,9 W	2762m	2774m	bottom contact
	16:00	CTD		42° 09,0 N	010° 30,0 W	2763m	200m	
	16:11	MUC		42° 08,9 N	010° 29,9 W	2762m	2780m	bottom contact
	19:04	KaL		42° 09,0 N	010° 30,0 W	2761m	2783m	bottom contact
	21:35	BWS		42° 09,0 N	010° 30,1 W	2766m	2783m	bottom contact
25	13:52	GKG		39° 29,8 N	009° 55,3 W	3469m	3505m	failure
	15:53	GKG		39° 29,8 N	009° 55,4 W	3612m	3601m	failure
	17:51	GKG		39° 29,7 N	009° 55,4 W	3514m	3510m	bottom contact
	20:12	MUC		39° 29,7 N	009° 55,5 W	3526m	3549m	bottom contact
	22:37	MUC		39° 29,7 N	009° 55,5 W	3554m	3554m	bottom contact
	00:56	MUC	11.1	39° 29,7 N	009° 55,5 W	3509m	3562m	bottom contact
	02:28	CTD		39° 29,8 N	009° 55,5 W	3456m	900m	
	04:56	CTD		39° 29,8 N	009° 55,4 W	3602m	3500m	
	06:14	HS / PS		39° 29,8 N	009° 55,5 W			profile start various courses in the Nazare Canoyn
	08:00			39° 31,8 N	009° 48,5 W			various courses
	08:21			39° 31,7 N	009° 46,1 W			course change to rwK151°
	09:10			39° 29,0 N	009° 45,1 W			profile end
26	09:20	GKG	12.1	39° 29,0 N	009° 45,1 W	2816m	2859m	bottom contact

	12:05	GKG		39° 29,0 N 009° 45,1 W	2894m	2883m	bottom contact
	14:13	MUC		39° 29,0 N 009° 45,1 W	2890m	2878m	bottom contact
	16:14	MUC		39° 29,1 N 009° 45,0 W	2898m	2916m	bottom contact
	18:03	MUC		39° 29,0 N 009° 45,0 W	2893m	2890m	bottom contact
27	12:57	GKG	12.1	39° 34,0 N 010° 10,3 W	4141m	4183m	bottom contact
	16:08	MUC		39° 33,9 N 010° 10,0 W	4121m	4176m	bottom contact
	18:54	KaL		39° 33,9 N 010° 09,9 W	4121m	4194m	failure KaL got bent
	21:21	CTD		39° 34,0 N 010° 09,9 W	4120m	4000m	
28	17:23	CTD	13.1	36° 33,1 N 008° 30,0 W	2260m	300m	
	19:03	CTD		36° 33,1 N 008° 30,2 W	2172	2000m	
	00:02	HS / PS	14.1	37° 00,0 N 008° 10,0 W			profile start (Faro) rwK 104°
	01:08			36° 58,0 N 008° 00,0 W			course change to rwK122°
	01:48			36° 55,5 N 007° 55,0 W			course change to rwK058°
	02:17			36° 58,0 N 007° 50,0 W			course change to rwK076°
	03:44			37° 00,0 N 007° 40,0 W			profile end

Abbreviations:

BWS:	Bottom water sampler
CTD:	Salinity-temperature-water sampling devise with rosette system
GKG:	Box corer
HS:	Hydrosweep
KaL:	Box lead
MUC:	Multicorer
PS:	Parasound
ADCP:	Acoustic doppler current profiler

Meteor cruise 43/2 was a successful winter cruise providing very important samples for the OMEX project. The results will significantly contribute to construct seasonal budgets for the upwelling area off Portugal and will help to validate physical models of the area.

9 References

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